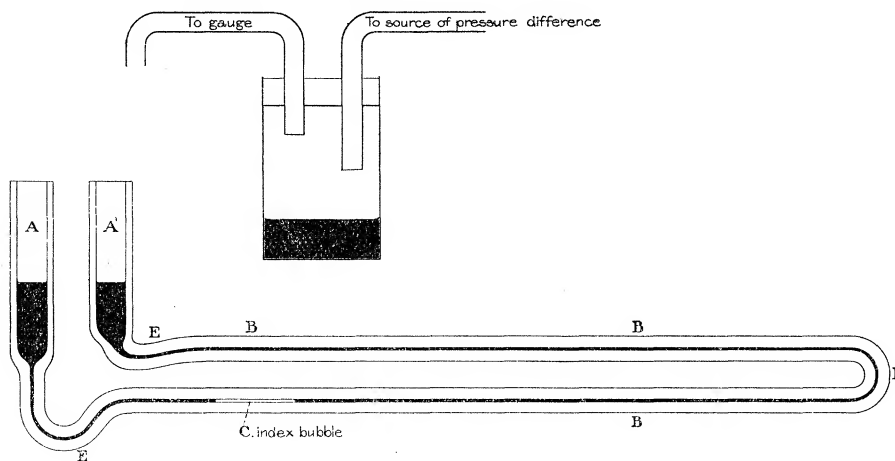


On a Compensated Micro-manometer.

By BERTRAND J. P. ROBERTS.

(Communicated by Sir John I. THORNYCROFT, F.R.S. Received
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The accompanying sketch shows a form of fluid-pressure gauge or micro-manometer, intended for use as an anemometer and for the indication and measurement of small pressures.*



Ratio : approximately 10 : 1 diameter of bores.

A design for a sensitive pressure gauge, or micro-manometer. Anti-evaporative attachment for use with volatile fluids; one should be connected in series with each side of the gauge—only one shown. A Woulff's bottle with three necks would be a convenient substitute. Cal. chlor. tube should be used also in case of hygroscopic fluid in gauge.

The two limbs A and A' of a U-tube are connected by a tube of finer bore B, and this tube B contains an index bubble—preferably of air, C, the bends at E form a trap, to prevent the accidental loss of the bubble. The small separate part is an arrangement for preventing loss by evaporation in the case of volatile fluids—it does not need description. The sensitiveness of the gauge obviously depends on the ratio between the bores of the limbs and the connecting tube—this is approximately 10 : 1 in the example shown; also to some extent on the fluid employed in the gauge, and the fluid used should depend on the intended application and on the degree of sensitiveness desired.

* The feature in which this arrangement differs from Sir W. Siemens' bathymeter is the compensation.

The length of the index bubble C should be approximately equal to the distance between the centres of the limbs A, A'; it will then be found that the gauge is practically indifferent to changes of position or level, as the effect of the air bubble (while in the *lower* horizontal tube) will counteract the effect due to any change of level of the limbs A and A'; it is, of course, not possible to exactly compensate for this, as the length of the bubble will vary slightly with the temperature and the barometric pressure. Any tendency to error in the readings from these two last-mentioned causes can be obviated by observing both ends of the index bubble; but, as it is not necessary to read very minutely, owing to the multiplying effect, this source of error can generally be neglected.

It is not advisable to employ a larger bore for the tube B than 2 mm., and $1\frac{1}{2}$ mm. is preferable, as the surface tension is insufficient (with most fluids) to prevent fluid from passing the air bubble in larger bores; the limit to the smallness of the bore depends on the viscosity of the fluid and the rapidity of readings desired. For the same reasons it is not practicable to use pure water as the working fluid, as owing to its high surface tension the zero point is very indefinite; water *can* be used, however, if some substance, such as glycerine or calcium chloride, is added to lower the surface tension.

The writer cannot say definitely what is the limit of sensitiveness that can be reached—this depends on the resistance offered by the surface tension and viscosity of the fluid to the motion of the index bubble—making its movements very slow, so that in returning to zero it may take five minutes or more, with a very sensitive form—using alcohol. To reduce this effect as much as possible it is necessary to use either alcohol or ether (and perhaps pentane) for the most delicate results.

The air bubble acts practically as a piston, and no fluid can be seen to pass it at a normal rate of movement, but fluid can be caused to pass in a thin film if the bubble is forced to move rapidly. There seems to be a critical speed—for each size of bore and fluid—above which the surface tension is unable to overcome the adhesion of the fluid, to the walls of the tube, quickly enough.

In connection with this I have noticed an interesting effect—showing well the rapidity of the motion of fluid in the centre of tubes, and the almost stationary condition of the layer next the sides.

If a small bore—say 2 mm.—tube, similar to the gauge described above, and containing an air bubble, filled with uncoloured alcohol, be taken, and some coloured alcohol is added to one limb, then the air bubble moves at the average velocity of the fluid, but the coloured alcohol entering the tube will

be seen to be drawn, or rather pushed, out in a long conical point, moving much more rapidly than the bubble, and eventually overtaking it and turning over; the fluid at the sides will be still quite uncoloured until mixed by diffusion; to a certain extent the effect is reversible, and the cone of coloured alcohol can be drawn back without mixing very much.

The device shown for preventing evaporation should be in duplicate, one to each limb; only one is shown, as an example.

On the Hygroscopic Action of Cotton.

By ORME MASSON, D.Sc., F.R.S., and E. S. RICHARDS, B.Sc.

(Received June 25,—Read June 28, 1906.)

In an earlier paper by one of us* an account was given of the behaviour of dry cotton-wool when immersed in air saturated with water vapour, and the relation between the hygroscopic absorption and the change of temperature which the cotton manifests was investigated. It was shown that, so long as the surrounding air is saturated, the absorption process appears to be unending, though its velocity continuously diminishes; or, in other words, true equilibrium between such an atmosphere and cotton wool, however moist, appears to be impossible, just as it would be impossible between the same atmosphere and an aqueous solution, however dilute. It was pointed out, however, that "if placed in an atmosphere containing water vapour at anything less than saturation pressure (*e.g.*, in the open air) the cotton would in time reach a state of equilibrium, either by absorption or by evaporation, according to its initial condition." As we could find no record of any complete investigation of such relationship, it seemed desirable to determine the amounts of vapour absorbed by a given quantity of cotton in atmospheres of various known degrees of humidity. This has been done; but it has been found necessary to determine the true equilibrium values by approaching them from both sides, by absorption and by evaporation, since neither process becomes really complete in any practicable time, though each leads in a few hours to what might be mistaken for true equilibrium.

Reference must here be made to the interesting work published by Clayton Beadle, in 1894 and 1895,† which was unfortunately entirely

* 'Roy. Soc. Proc.,' vol. 74, pp. 230—254.

† 'Nature,' vol. 49, p. 457; 'Chem. News,' vol. 71, p. 1; *ibid.*, vol. 73, p. 180.